BULLETIN

OF THE

Society for the
Promotion of Engineering Education

Vol. I LANCASTER, PA., MAY, 1911 No. 10

EDITORIAL.

Our New Members.—The Society is to be congratulated upon the fact that engineers of the highest standing are joining it in large numbers. They will be interested as long as fundamental, vital issues are considered. Non-teaching engineers are just as much concerned with the results of technical training as are those engaged in instruction. This Society has an important function in bringing together all persons concerned directly or indirectly with the promotion of engineering education.

A Milestone Passed.—The members and applicants now bring the Society membership above 1,000. The ambition of the membership committee is not so much to secure many members as it is to bring together all who should be in the Society. There are many young instructors as well as many non-teaching engineers who are still outside the membership. Will not each member who values the Society extend an invitation to one or more of these?

The Bulletin.—The fate of the BULLETIN will be decided at the coming annual meeting. The members of the Council are now balloting on the matter for, if their recommendation requires any constitutional amendment, an affirmative vote must be secured at least thirty days before the annual meeting. The Program Committee has prepared a preliminary report showing that with a slight increase in dues it will be possible to continue the publication. It would be helpful to the

Council if the members would write to the President or the Secretary stating their views regarding the desirability of continuing the publication. Some months ago a provisional subscription card was sent out with a view to ascertaining the views of the membership as to the value of the BULLETIN. Each member was requested to fill in and return at once a provisional subscription card which was to be binding only in case the dues are reduced to $3.00. This makes the BULLETIN cost fifty cents. While a large number of these were returned the total was not enough to warrant the Program Committee in recommending this plan for, if but one fourth of the membership think enough of the BULLETIN to return this card, it would be impossible to secure enough subscriptions to support it.

The Convention.—The Pittsburgh Committee is actively at work planning for the convention which will take place in that city on June 27, 28 and 29. In order to prepare the members to make the most of the meeting members of the local committee have been requested to prepare brief articles descriptive of the attractions of the city and its educational institutions. Dean Leete, chairman of the committee, writes "we have every desire to make the meeting a rousing success."

The Report of the Committee on Entrance Examinations.—The first installment of the report is printed in this issue and the remainder will appear in the June BULLETIN. It is hoped that the report will prove acceptable to the Society and that it will be adopted at the coming meeting. Members are especially urged to study the report and write their criticisms and suggestions to Professor Flather, the chairman, at once.

The Mathematics Report.—The Committee has now completed the report as they intend to present it at the Pittsburgh meeting. At first the plan included a section on "dynamics" but it has been found impracticable to complete an outline, which is satisfactory to the Committee, in the limited time available. The chairman has worked diligently on the report all this year in addition to having done a vast amount of preparatory work during the preceding two years. The chair-

man will welcome the criticisms and suggestions of the members of the Society.

NEW MEMBERS.

By letter ballot the Council has elected the following to membership in additions to the applicants listed on pp. 508 and 509 of the April BULLETIN. A complete list of the new members arranged for pasting in the January BULLETIN is enclosed with this number.

BERRESFORD, A. W., Vice-President and General Manager, The Cutler-Hammer Mfg. Co., Milwaukee, Wis. 1911

BLAND, J. C., Engineer of Bridges, Pennsylvania Lines West of Pittsburgh, Pittsburgh, Pa. 1911

BLUME, L. F., Electrical Engineer, General Electric Co., Pittsfield, Mass. 1911

CHESNEY, C. C., Manager and Chief Engineer, General Electric Co., Pittsfield, Mass. 1911

COFFIN, C. A., President, General Electric Co., 145 W. 58th St., New York, N. Y. 1911

COSTER, E. L., Literary Engineer, 25 Broad St., Rooms 1440–45, New York, N. Y. 1911

DUNN, GANO, Vice-President and Chief Engineer, Crocker-Wheeler Co., Ampere, N. J. 1911

FRITH, A. J., Associate Professor of Mechanical Engineering, Armour Institute of Technology, Chicago, Ill. 1911

FRY, L. H., Technical Representative in Europe, Baldwin Locomotive Works, 64 rue de la Victoire, Paris, France 1911

GARDNER, HENRY, Assistant Superintendent of Apprentices, New York Central Lines, White Plains, N. Y. 1911

GEIER, F. A., President, The Cincinnati Milling Machine Co., Cincinnati, O. 1911

GERHARD, W. P., Consulting Engineer for Hydraulic and Sanitary Works, 39 Strong Place, Brooklyn, N. Y. 1911

GILCHRIST, J. F., Assistant to the President, Commonwealth Edison Co., Chicago, Ill. 1911

GRIMM, C. R., Standish Arms, 169 Columbia Heights, Brooklyn, N. Y. 1911

HAGERTY, C. T., Professor of Mathematics and Astronomy, New Mexico College of A. & M. Arts, Agricultural College, New Mexico 1911

HARAHAN, W. J., Vice-President, Erie Railroad Co., Montclair, N. J. 1911

HEWERDINE, T. S., Professor of Civil Engineering, Nova Scotia Technical College, Halifax, N. S. 1911
HYDE, E. P., Director Physical Laboratory, National Electric Lamp Association, Cleveland, O. 1911
LOVELACE, B. F., Professor of Chemistry, University of Alabama, University, Ala. 1911
MAIN, C. T., Consulting and Constructing Engineer, 14 Herrick St., Winchester, Mass. 1911
MARKS, W. D., Consulting Engineer, Park Row Bldg., New York City 1911
MOSS, S. A., Engineer, Turbine Research Dept., General Electric Co., Lynn, Mass. 1911
MUHLFELD, J. E., Vice-President and General Manager, Kansas City Southern Railway, Kansas City, Mo. 1911
POPE, WILLARD, Vice-President and Engineer, The Canadian Bridge Co., Ltd., Walkerville, Ontario 1911
POWERS, E. L., Editor GOOD ROADS, 150 Nassau St., New York City 1911
STILLMAN, F. H., President, The Watson-Stillman Co., 50 Church St., New York City 1911
VON ENDE, C. L., Professor of Chemistry, University of Idaho, Moscow, Idaho 1911
WELLS, G. A., Chief Engineer, Adams Express Co., 59 Broadway, New York, N. Y. 1911
WHITE, JAS. G., President, J. G. White & Co., Inc., New York, Chairman, J. G. White & Co., Ltd., London 1911

APPLICANTS FOR MEMBERSHIP.

BECKSTRAND, E. H., Professor of Mechanical Engineering, University of Utah, Salt Lake City, Utah..... 1911
BRADFORD, R. H., Professor of Metallurgy, University of Utah, Salt Lake City, Utah..... 1911
BRATTON, W. A., Professor of Mathematics, Whitman College, Walla Walla, Wash. 1911
CARNEGIE, ANDREW, 2 E. 91st St., New York City..... 1911
CHARTERS, S. B., Jr., Asst. Professor of Electrical Engineering, Leland Stanford Junior University, Stanford University, Calif. 1911
CLOKE, PAUL, Instructor in Electrical Engineering and Physics, Rhode Island State College, Kingston, R. I. 1911
DAY, CHARLES, of the firm of Dodge, Day and Zimmerman, Consulting Engineers, 608 Chestnut St., Philadelphia, Pa. 1911
DENT, J. A., Instructor in Mechanical Engineering, University of Illinois, Urbana, Ill. 1911
DYSART, P. M., Head of Physics Dept., Pittsburgh Central High School, Pittsburgh, Pa. 1911

FOSTER, E. S., Instructor in Electrical Engineering, Lehigh University, S. Bethlehem, Pa. 1911

GIBSON, J. L., Professor of Mathematics, University of Utah, Salt Lake City, Utah 1911

HERING, RUDOLPH, Hydraulic and Sanitary Consulting Engineer, 170 Broadway, New York, N. Y. 1911

HOLT, T. P., Instructor in Mining and Milling, University of Utah, Salt Lake City, Utah 1911

HUBBARD, L. L., General Manager, Michigan College of Mines, Houghton, Mich. 1911

HUNT, G. H., Instructor in Mechanical Drawing and Descriptive Geometry, Case School of Applied Science, Cleveland, O. 1911

KELSALL, G. A., Instructor in Electrical Engineering, Michigan Agricultural College, East Lansing, Mich. 1911

KETCHUM, R. B., Associate Professor in Civil Engineering, University of Utah, Salt Lake City, Utah..... 1911

KNOWLTON, A. A., Associate Professor in Physics, University of Utah, Salt Lake City, Utah 1911

LANE, F. W., Editor National Land & Irrigation Journal, 6438 Normal Ave., Chicago, Ill. 1911

LINCOLN, P. M., Electrical Engineer, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa. 1911

MCGAW, F. M., Assistant Professor in Mathematics, Cornell College, Mt. Vernon, Iowa 1911

MOLLESON, G. E., 50 Church St., New York City..... 1911

MOOMAW, DALTON, Instructor in Mechanics and Hydraulics, Case School of Applied Science, Cleveland, O. 1911

OSBORNE, L. A., Vice-President, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa. 1911

PACK, F. J., Professor of Geology, University of Utah, Salt Lake City, Utah 1911

PHILP, B. K., Instructor in Civil Engineering, Michigan Agricultural College, East Lansing, Mich. 1911

POORE, O. B., Contracting and Consulting Engineer, Mason, Ohio.. 1911

ROSING, A. S., Assistant Professor of Civil Engineering, Michigan Agricultural College, East Lansing, Mich. 1911

RYAN, W. T., Assistant Professor of Electrical Engineering, University of Minnesota, Minneapolis, Minn. 1911

STOTT, H. G., Superintendent of Motive Power, Interborough Rapid Transit Co., New York, N. Y. 1911

THAYER, H. R., Assistant Professor in Structural Design, Carnegie Technical Schools, Pittsburgh, Pa. 1911

TOWER, C. H., Instructor in Electrical Engineering, Cornell University, Ithaca, N. Y. 1911

TURNER, W. S., Consulting Engineer, 1008 Spaulding Bldg., Portland, Ore. 1911
WEED, J. M., Chairman of Student Apprentice Committee, General Electric Co., Pittsfield, Mass. 1911
WESTON, EDWARD, President The Weston Electrical Instrument Co., Waverly Park, Newark, N. J. 1911

CHANGES IN MEMBERSHIP LIST.

Bickford, H. C. (5034 Catherine St., Philadelphia, Pa.); Biegler, P. S. (Purdue University, West Lafayette, Ind.); Bowerman, M. R. (2126 S. Central Park Ave., Chicago, Ill.); Burt, H. J. (1618 Monadnock Block, Chicago, Ill.); Mehrtens, A. C. (346 Holcomb Ave., Detroit, Mich.); Nunn, P. N. (The Telluride Power Co., Provo, Utah); Roberts, W. J. (State Highway Commissioner, Olympia, Wash.); Schaphorst, W. F. (1572 Hudson Terminal Bldg., New York, N. Y.); Zimmerman, O. B. (c/o E. Burner & Co., South Bend, Ind.).

LETTERS TO THE EDITOR:

NEW YORK, April 6, 1911.

HENRY H. NORRIS, *Secretary,*
Society for the Promotion of Engineering Education,
Cornell University, Ithaca, N. Y.

Dear Sir: Mr. Hamerschlag has sent me your letter of March 15th. I am pleasd to hear that the Carnegie Technical Schools are to take an activ part in the meeting of your Society for the Promotion of Engineering Education. Stedily do we recognize more and more the value of what mite be cald practical education in connection with the sciences, of which engineering is one of the foremost, and less and less are the ancient classics considered. Herbert Spencer profesied that the enormous amount of time bestowd upon these by this generation will be considered "one of the aberrations of humanity." This I hav long believd to be correct.

Always very truly yours,
ANDREW CARNEGIE.

SECRETARY S. P. E. E.,

Dear Sir: I am submitting herewith an outline of an engineering course which Whitman College proposes to introduce. If you study it carefully you will discover that it contains some variations from the established courses in most engineering schools. I am anxious that we might have the opinion of some eminent engineers concerning their feeling as to its advantage or disadvantage.

You will notice that it makes cultural studies the chief part of the course, and eliminates shop and manual training from the work in the College, aiming to substitute for this practical experience to be gained in the summer time by actual work in the mill or factory or mine.

It is proposed to make the industries and the corporations which are interested in the development of this country, the schools through which the young men in training for engineering in this institution shall receive their practical application of the theories they receive here. There is a disposition on the part of these industries and corporations to accept this program, so that the practicability of that need not enter into your discussion or consideration of this course.

There is no intention on the part of the authorities to limit the shop work requirements to summer vacation entirely, the agreement with the various industries being that such amount of shop work shall be granted us within these industries as in the opinion of our instructors is considered sufficient. We will undoubtedly use the laboratory method wherever it is found desirable.

I should be pleased to have the new curriculum published in the BULLETIN, as you suggest, inviting suggestions from engineers and educators who are competent to express opinions.

Yours sincerely,

A. W. HENDRICKS, *Dean.*

WALLA WALLA, WASH.

Entrance Requirements.—Same as B.S., plus Mechanical Drawing and Trigonometry, and with entrance examination in Algebra and Trigonometry. Latin, 2 years; French or German, 2 years.

Freshman.

English 1 and 5	3
French or German	3
Mathematics	4
College Algebra.	
Analytics.	
Bible	1
Drawing	1
Chemistry 1 and 2	3
Physics	3
Mechanics.	
Heat.	
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Sophomores.

English 7	3
French or German	2
Mathematics	3
Calculus.	
Descriptive Geometry	2
Surveying	1
(plus three weeks' field work.)	
Chemistry 2 and 3	3
Physics	4
Electricity.	
Light.	
Sound.	
	18

Note.—Two summer vacations with detailed reports: (1) surveying and field work, (2) shop work in factories, etc. The French or German of Freshman and Sophomore years shall follow German or French presented for entrance.

Juniors.

Philosophy 3 and 4	2
History 5 and Political Science	3
Geology	2
Applied Differential Equations and Theoretical Mechanics	2
Mechanisms	2
Valve gears.	
Kinematics.	
Machine Design.	
Graphical Statics	1
Industrial Chemistry	1
Physics	2
Mechanics.	
Hydraulics.	
Electives	3
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Seniors.

Economics	3
Astronomy and English Constitutional History	2
Nomography	1
General Lectures	1
Reports and Specifications	1
Structural Engineering	5
Power Plants	2
Electives	3
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ELECTIVES.

Electrical.

Thermodynamics.
Steam Engines.
Dynamos.
Electrical Transmission.
Alternating Currents.

Mining.

Thermodynamics.
Determin. Mineralogy.
Metallurgy.
Geology and Metallurgy.
Assaying.
Mine Surveying.
Mine Sampling.

	Civil.	*Mechanical.*
Junior.	Municipal Engineering.	Thermodynamics.
	Water Supply.	
	Paving.	
	Sewerage and Disposal.	
	Highway Engineering.	Steam Engines.
	Sewer Construction.	Dynamos.
Senior.	Railroad Engineering.	Fuel and Oil Analysis.
	Irrigation Engineering.	Boilers, etc.
	Surveying.	Condensers.
		Gas Engines.

COLLEGE NEWS.

University of California.—During the past month a situation has been met, which we have considered of vital importance to the proper growth of engineering schools in this State. Representatives from the southern portion of California introduced into the State Legislature at Sacramento a bill known as the "Gates Bill," asking that the Legislature appropriate as a beginning $100,000 to establish a School of Technology at Pasadena. It was explained that should such an appropriation be made by the State, the Throop Polytechnic Institute, at present privately endowed, would turn over to the State its lands and equipment. The bill was opposed primarily by those interested in the welfare of the State University of California at Berkeley. The prominent opponents to the bill were mainly graduates of the University of California. It was their belief that if such a bill passed, it would eventually produce not only two engineering institutions in the State supported by the State, but that inevitably a second university, giving instruction in varied fields, would be the result. Unfortunately the issue produced some bitter controversy. Last month the bill was lost by vote in the State Senate.—California at present is supporting two large universities—the University of California and Stanford University. Technical instruction is given also to some degree at the University of the Pacific at San Jose, at the Throop Polytechnic Institution in Pasadena, and at the University of Southern California

in Los Angeles. Those who have the best interests of engineering education in the West at heart believe that a further increase in the present number of engineering schools is a mistake. The history of education in other States, such as Missouri and Colorado, would lead one to believe that there is truth in such a view point. It is thought that what we need in any one State is rather a concentration of educational activities for higher professional studies; not a duplication of institutions. We think that such a duplication will diffuse support and weaken the cause. These remarks are presented with the view that they will be of vital interest to the readers of the BULLETIN. There should be more discussion on such issues. If similar conditions exist in other states, they should be explained and discussed. The public cannot be too intimately informed of the trend of events and of the difficulties which may arise, due to the duplication of engineering schools in any one locality.

Clarkson School of Technology.—The fifteenth anniversary of Charter Day was commemorated on Friday, March 17. Mr. M. N. Baker, of the *Engineering News*, delivered the address. His title was "The Engineer and Social Service." The school has published a leaflet giving an abstract of the address.

Dartmouth College.—The Thayer School of Civil Engineering, Dartmouth College, expects to occupy enlarged quarters towards the close of the present calendar year. The trustees have assigned Bissell Hall (old gymnasium), recently vacated, which will be entirely rebuilt within by fireproof construction, and will have floor space more than two and a half times greater than that of the present Thayer building which has been inadequate for some years. Each class will have a drawing room for its exclusive use, and the senior (post-graduate) class a separate room for its class-work, convenient to the library and reading room. The hydraulic, electrical and cement and concrete laboratories will be arranged and equipped for securing most effective operation. The prominent location on the campus is appropriate to the history and work of the school.

University of Illinois.—The board of trustees announces a gift by Mr. F. J. Plym of the class of '97, amounting to one thousand dollars for a term of years, for the purpose of establishing an advanced fellowship in architecture. The first award of the fellowship will be for the year 1911 and '12. Information regarding the award may be had upon application to Professor F. M. Mann, Department of Architecture, University of Illinois.—The Carnegie Institution has recently published the results of researches by Dean Goss on Superheated Steam in Steam Boilers. The publication is No. 127. This is a companion research to that published in No. 66 on High Steam Pressures in Locomotive Service.—George Alfred Goodenough, for many years Associate Professor of Mechanical Engineering of the University of Illinois, has been promoted to be Professor of Thermodynamics.—Professor Charles Russ Richards, Dean of the College of Engineering of the University of Nebraska, has been appointed Professor of Mechanical Engineering in Charge of the Department at the University of Illinois, effective September 1, 1911.—There have recently been installed at the University of Illinois, through the combined efforts of the Department of Electrical Engineering, The Engineering Experiment Station and the Department of Chemistry, two electric furnaces. One of these is a Hoskins resistance furnace and the other a Colby induction furnace. Both are of 20 kw. capacity. The furnaces will be used for the purpose of studying the changes that can be brought about in the mechanical and physical characteristics of cast-iron through the influence of the soaking process which it is possible to maintain.

University of Maine.—Under the auspices of the University of Maine Society of Civil Engineers, Professor C. F. Allen, professor of railroad engineering at Massachusetts Institute of Technology, gave two illustrated lectures before the society on the "Development of the Railroad Locomotive" and "Signals and Signalling."—Under the auspices of the Student Section of the American Institute of Electrical Engineers, Professor Harold B. Smith, director of Electrical Engineering at Wor-

cester Polytechnic Institute, presented two lectures, one to the seniors in Mechanical and Electrical Engineering on "Some Business Principles Useful to the Young Engineer" and the other before the society on the "Electrical Field of Force" embodying the results of the lecturer's researches on this subject. The paper dealt in the main with a demonstration of a new type of an electric motor operated from a high-voltage circuit and some new features in the design of insulators, especially a substitute for porcelain. In this respect, the research work of Professor Smith in this country, and that of an authority in Germany lead to identical results, though the experiments were independent and separate.—The Maine Alpha Chapter of Tau Beta Pi was installed on March 11, by Professor L. E. Moore of the Massachusetts Institute of Technology, president of the Executive Council.

University of Manitoba.—The staff of the University was very considerably increased last year by the following appointments: G. Halstead, lecturer in materials and hydraulics; L. I. Johnstone, lecturer in surveying and geodesy; L. R. Thomson, lecturer in drawing statics; J. W. Dorsey, lecturer in electrical engineering; R. C. Wallace, lecturer in geology and mineralogy; C. J. Triggerson, lecturer in zoölogy; L. A. H. Warren, lecturer in mathematics; T. A. Neelin, demonstrator in physics; Baldur Olsen, demonstrator in chemistry.—At present the University gives instruction only in the natural and physical sciences, civil and electrical engineering, mathematics, English, history and political economy, while the other arts and medical subjects are taught in the affiliated colleges. The following colleges are affiliated with the University: St. John's College (Anglican), Wesley College (Methodist), Manitoba College (Presbyterian), St. Boniface College (Roman Catholic), Manitoba Medical College, Manitoba College of Pharmacy, Manitoba Agricultural College. The total number of students in attendance at the University is about 700. The engineering courses have only been in existance three and a half years and have now an enrollment of 57. The F. W. Heubach Co. have given the University a new site

of 160 acres, situated about four and a half miles from the center of the city and it is expected that improvements will be made on this site during the coming summer. Among the first buildings to be put up on this site will be an engineering building. At present there is no president but it is expected that this appointment will be made during the summer.

University of Nebraska.—In January the *University Journal* published an engineering number. A large portrait of Dean Richards occupies the front page. Within are a number of articles describing the work of the University and its prominent alumni. An alumni directory is also included.

New Mexico College of Agriculture and Mechanic Arts.—Professor W. F. Schaphorst, of the Mechanical Engineering Department of the New Mexico College of Agriculture and Mechanic Arts, has resigned his position there to become a technical writer on the staff of A. Eugene Michel, advertising engineer, New York City.

Northwestern University.—The University has published a handsome booklet entitled "Evanston as a Residence for Students." The booklet is well illustrated.

South Dakota State College.—This college has recently issued a bulletin dealing solely with the engineering work of the institution. A brief sketch of the history of engineering education in the State of South Dakota is first given. Then the need of thorough and systematic training for any engineering profession is argued. After this the general scope and purpose of each engineering course offered are set forth. The equipments of the various laboratories are in part described and in part shown by some fifteen illustrations made from special photographs.—On Tuesday, April 11, Professor Solberg, of the South Dakota State College, gave a lecture before the general assembly of the students on "Niagara Falls and Its Power Developments." The lecture was illustrated by maps and diagrams constructed for the occasion.

University of Southern California.—A great many students taking the course in electrical engineering have enrolled as student members of the local section of the Institute of Electri-

cal Engineers, and are receiving the advantages of hearing the discussion of many problems of engineering practice.—The Pacific Coast Section of the Institute of Electrical Engineers will hold a meeting in Los Angeles in April. Students of electrical engineering will attend the sessions and participate in the excursions to the power plants and factories of the city.—Mr. Horatio Foster presented a talk on the subject "What an Engineer Has to Be" before the students of engineering on March 15. An effect is being made to bring many of the ethical problems which the engineer must solve before the student as early in the college life as possible.

Washington University (St. Louis, Mo.).—Professor Van Ornum recently contributed to the *University Bulletin* an article on "The Elements of Effective Education." This has been reprinted and those interested can probably secure copies by addressing Professor Van Ornum.

THE PITTSBURGH CONVENTION.

By way of preparing the members of the Society to get the greatest possible benefit from the Pittsburgh meeting the Program Committee has requested short articles from members of the local committee on the several phases of the industries and the educational institutions of Pittsburgh. The details of the program will be given in the June number. The following articles on Pittsburgh, the Carnegie Technical Schools, and the University of Pittsburgh will serve as an introduction to the program of the convention.

PITTSBURG.

BY MR. CHAS. F. SCOTT.

Pittsburg, the engineering center of the country, is a Mecca for engineers. Here are concentrated industrial works which receive as raw material the output of the engineering colleges. Here the professor may find the field in which his product is to be applied, and can observe at first hand the conditions which are to be met. The following general information, compiled from various sources, principally from information which has been prepared by the local committee of the American Society of Mechanical Engineers preliminary to its Pittsburg meeting, May 30 to June 2, is printed here to give a general survey of the principal features in the Pittsburg district.

Little is said here of parks, boulevards, clubs, hotels, public schools, and the like, nor is the list of industries complete. It indicates, however, the field from which the local committee will draw in making its arrangements for excursions of the visiting members.

Allegheny Observatory.—This observatory, noted for the discoveries by Langley and Keeler, has recently been rebuilt and now possesses a monumental building in Riverview Park, Northside, Pittsburg, and has an exceptionally excellent equipment.

American Bridge Company.—The works at Ambridge, recently built, are of mammoth size, and are devoted to steel construction for bridges and buildings.

American Locomotive Company.—Manufacturers of all types of locomotives from the smallest to the largest sizes. Have a capacity of one locomotive per working day. Employs 2,000 men and the works occupy eight city blocks on the east side of the Ohio River.

American Sheet and Tin Plate Company.—Of the total of 438 plants operated by this company, 63 per cent. are located in the Pittsburg district, employing 15,000 men. Company manufactures black and tinned plates, black and galvanized sheets, range of operation includes open hearth steel, rolling of sheet bars and the finishing of bars into black and coated products.

Armstrong Cork Company.—Large importers of cork and manufacturers of a great variety of commercial articles made from this interesting material.

Carnegie Library and Institute, Schenley District, Pittsburg, Pa.—Occupying a massive structure covering more area than the capitol at Washington. Donated to the city of Pittsburg by Andrew Carnegie, contains libraries, art galleries, museum, music hall and lecture hall.

Central District and Printing Telegraph Company (local Bell Telephone System).—This company has an extensive plant on Seventh Avenue, in which building are located four exchanges covering the Pittsburg district. The exchange handling the down-town local traffic handles, on an overage, 130,000 calls per day and requires 75 operators during the peak. One exchange is devoted to teaching new operators.

Carnegie Steel Company.—Employes 39,000 men. Operates 59 blast furnaces, 139 basic open hearth furnaces and rolling mills. Annual capacity 7,500,000 tons of pig iron and 9,000,000 tons of steel ingots. Manufactures finished steel products, boiler and tank plates, structural shapes, rolls, tie plates, splice bars, armour plate, blooms, billets, slabs, sheet bar, merchant bar, concrete bars, hoops, high grade alloy steel, steel car wheels, steel axles and sheet tiling.

The plants in the Pittsburg district are as follows: Clairton, Duquesne, Bessemer, Rankin, Homestead, McKees Rocks, Etna, Lucy and Isabella Furnaces.

Crucible Steel Company of America.—This company operates numerous plants, the largest of which is the Park Works in Pittsburg for the manufacture of crucible steel, as well as many special grades of acid and open hearth steel. It contains a 60-pot crucible furnace, the largest in the world.

Firth-Sterling Steel Company (McKeesport, Pa.).—Manufacturers of fine crucible steel for tool purposes. An interesting feature of this plant is the 2½-ton Heroult electric furnace which is charged either cold or with metal from an open-hearth furnace. One resistance electric furnace is also installed.

H. C. Frick Coke Company.—Owns and controls about 62,000 acres of coking coal in the Connellsville Region, which is adjacent to Pittsburg. Has 72 plants with an aggregate of 21,100 coke ovens, having an annual capacity of 24 million tons of coal and 14 million tons of coke. Employs when in full operation 23,000 men. During the past sixteen years wages have been based on selling price of the product—practically a sliding scale. Success of this method shown by fact that during this period there have been no labor troubles or wage disputes. The operating rules of company are: Safety, the first consideration; quality of products, the second; cost of production, third. The company has extensive relief and accident funds for employees.

H. J. Heinz Company.—Manufacturers of the famous pure food products. The cleanest, largest and best equipped establishment of its kind in the world. Has over 4,000 employees. An interesting sight is afforded those seeing the "57 Varieties" prepared by uniformed workers in the up-to-date kitchens.

The Jones and Laughlin Steel Company.—This is one of the largest of the independent steel companies operating coke ovens, blast furnaces, open hearth and bessemer departments, structural shop, chain shop, spike shop, etc. Talbot furnaces of 200 tons capacity are in continuous operation.

McClintic-Marshall Construction Company.—Principal works at Rankin, nine miles east of Pittsburg, B. & O. R.R. The largest independent manufacturers of steel buildings and bridges in this country.

Capacity 150,000 tons per year. At the Rankin plant 50,000 tons of steel work are now being fabricated for the lock gates of the Panama Canal. Company also has plants at Carnegie and Pottstown, Pa.

McIntosh Hemphill Company.—Designers and builders of rolling mills, engines, and machinery for iron and steel work. Established more than a century ago. Have designed and built a large portion of the heavy machinery used in rolling mills of this country. Make a specialty of steel rails and pinions. Have steel, iron and brass foundries. Iron foundry has a capacity for turning out castings up to 240,000 pounds each; steel foundry—160,000 pounds each. Machine shop equipped for handling very large work.

Mesta Machine Company (Homestead, Pa.).—This company designs and builds heavy duty engines for blast furnaces, rolling mills, and power plants, steel mills, and similar classes of machinery.

The plant covers 20 acres of ground, 500,000 square feet of floor space, 80 per cent. of which is covered by electric traveling cranes. An interesting feature is a 4-ft. concrete slab upon which it is possible to erect four pairs of vertical cross-compound blowing engines, 48 ft. high at one time, without danger of settling out of alignment during erection.

Mines, Bureau of.—This division of the Department of Commerce and Labor was established at this point for the purpose of conducting investigations in mine accidents and fuels. There is also located here a testing laboratory of the United States Bureau of Standards.

Interesting experiments and tests can be witnessed here on the use of fuels and explosives.

National Tube Company (McKeesport, Pa.).—This works manufactures tubes and pipes of all kinds. The company has given special attention to the installation of devices for the safety of its employees.

Nernst Lamp Company.—Manufactures the well known Nernst lamp, a large installation of which has recently been made in the new Penna. Terminal, New York City.

R. D. Nuttall Company.—Manufacturers of cut and plain gears and pinions of all kinds, flexible cushion couplings and overhead car equipments.

Optical Works.—The factory of the John A. Brashear Company is well known for its production of high grade lenses.

Pennsylvania Smelting Company (Carnegie, Pa.).—This company is engaged in smelting a considerable variety of ores and in the production of lead and sulphur. The ores come from the Cobalt district in Canada and the Cœur d'Alene district in Idaho.

Pittsburg Filtration Plant (Aspinwall, Allegheny River).—The city of Pittsburg receives its water from the Allegheny River. The water is raised by large centrifugal pumps to the sedimentation reservoirs, from thence it flows over the gravel and sand filter beds, passing thence under the bed of the Allegheny river through two 72-inch pipes to the Brilliant pumping station from which it is pumped to the Highland Park Reservoirs and distributed over the city. The filter beds cover 56 acres.

Power House, Pittsburg Railways Company.—This power house, the largest generating station of this company, and one of the largest in this part of the country is located at Brunot's Island, Ohio River, one and one half miles below the junction of the Allegheny and Monogahela rivers. Total capacity 27,500 H.P. Contains reciprocating engines and steam turbines, the latter being in 3,000 and 5,000 K.W. units. Location of plant particularly suitable for securing coal and water.

Pittsburg-Buffalo Company.—One of the largest producers of bituminous coal in the Pittsburg district. Annual capacity of three million tons. Has contract for the output of four other companies, giving it an additional capacity of three million tons per year. The Marianna mine is the largest commercial coal plant in this country. Among the noteworthy features are—two steel mine cars, three tons capacity each, which can be hoisted on one cage and coal loaded on six railroad tracks at one time. Largest steel plate ventilating fan in the world, 35 feet in diameter and 8 feet wide. Provisions for convenience and entertainment of the employees are unique. Among these are—a bath house for 1,200 men, brick houses provided with running water and electric lights. An amusement hall containing theatre, skating rink and bowling alleys.

Pittsburg Meter Company.—East Pittsburg, twelve miles

from Pittsburg, Pennsylvania R.R. Manufactures gas and water meters.

H. K. Porter Co.—This company manufactures light locomotives.

Pressed Steel Car Company.—Manufacturers steel passenger, freight, trolley, subway and mine car equipments. Annual capacity 55,000 cars.

River Improvements.—The rivers about Pittsburg have recently been equipped by the government with new dams and locks.

The Standard Underground Cable Company.—These works manufacture insulated and lead-covered cables for electric service of all kinds.

United States Glass Co.—Largest glass manufacturing establishment in the world. Making table, bar, light cut and etching glassware.

United Engineering and Foundry Company.—Has three plants in the Pittsburg district, one at Vandergrift, Pa., one at Youngstown, Ohio, and one at Canton, Ohio. These plants form a unit which makes this company the largest concern in the world manufacturing rolling mill machinery. The 54th Street plant covers eleven acres of ground, has a foundry capacity of 800 tons per month. The machine shop is the largest one in Pittsburg district devoted to rolling mill machinery. The 61st Street plant has a capacity of 1,300 tons of rolls per month. Has five air furnaces and thirty-six roll lathes.

Universal Portland Cement Co. (Universal, Pa.).—Twelve miles from Pittsburg by air line, eighteen miles by railroad. Manufactures portland cement by using granulated blast furnace slag, obtained from the Bessemer Furnaces of the Carnegie Steel Co. and limestone which is quarried locally. Capacity 3,500,000 barrels per year. The company owns plants at South Chicago, Ill., and Buffington, Ind., making a total capacity of twelve million barrels per year. Plant is operated throughout by induction motors, energy for which is transmitted at 22,000 volts from the Carrie Blast Furnaces of

the Carnegie Steel Co., the generators in which are driven by gas engine supplied with the waste gases from the blast furnaces.

Union Switch and Signal Company (Swissvale, Pa.).—Eight miles east of Pittsburg. Manufactures and installs every kind of signalling and interlocking apparatus of recognized utility. Buildings cover 40 acres. Employs 3,000 men. Company originated, on electric railroads, signalling with a distinctive current, that is, using a different kind of current for signal control from that used for traffic propulsion.

Westinghouse Air Brake Company (Wilmerding, Pa.).—Fifteen miles east of Pittsburg. The oldest of the Westinghouse industries, established in 1869. The industry with which George Westinghouse began the labors which have made his name renowned. Manufactures air-brake equipment and friction draft gear for steam railroads, air compressors and traction brakes for electric railways. Employs 4,500 men; has a capacity of 1,000 brake sets per day. The largest brake building plant in the world.

Westinghouse Electric and Manufacturing Co.—Located at East Pittsburg, twelve miles from Pittsburg. Manufactures the widest variety of electrical appliances—from a lady's sad iron to the largest electric locomotive. Has over 50 acres of floor space and employs 14,000 people. The entire plant, which is under one connecting roof, requires a walk of over eight miles to cover same. A journey through the works gives one a panoramic view of the recent development in the field of electricity.

Westinghouse Machine Company (East Pittsburg, Pa.).—Twelve miles east of Pittsburg. Employs 2,150 people, has over twelve acres of floor space. Manufactures steam engines, steam turbines, gas engines, gas producers, condensers, mechanical stokers and reduction gears for turbines. An interesting feature is the original Westinghouse-Melville-Macalpine turbine reduction gear which may be seen by visitors. Also the largest absorption dynamometer ever built; has a record of 6,100 H.P. for forty hours' continuous operation.

THE CARNEGIE TECHNICAL SCHOOLS.

BY DEAN J. H. LEETE.

In giving Pittsburg the institute which bears his name, Mr. Carnegie had for a purpose the creation of an educational institution which should serve the intellectual life of the city as his steel works has served her material welfare. The activities of the institute proper are divided among three departments: Fine Arts, the Museum and the Technical Schools. The buildings also provide accommodations for the Carnegie Library of Pittsburg and a Hall of Music in which are given series of free organ recitals.

The Department of Fine Arts and of the Museum, together with the Library and Music Hall, are located in a building whose foundations were laid in 1892 and which was completed as it now stands and dedicated in 1907. It covers approximately six acres of ground at the entrance to Schenley Park, in a district which contains many of the finest public buildings of the city. The Department of Fine Arts has in its possession a permanent collection of the best modern painters and also holds an annual international exhibition which has become recognized as one of the best in the world. This international exhibition will be under way during the dates of the convention in June. The museum is recognized as one of the four great museums of the world.

The Carnegie Technical Schools occupy a site containing 32 acres adjacent to the institute. About one sixth of the proposed building program of the schools has been completed, the structures being placed so as ultimately to form a large quadrangle with a terraced campus in the center. Ground was broken for the first group of buildings in April, 1905, and in October of the same year a limited number of students were admitted. The registration for the current year is 2,226, of

which, in round numbers, 1,000 are day students and 1,200 night students.

Under the name "Carnegie Technical Schools" are included four separate schools each with its own faculty and student enrollment. The types of education offered in these four schools differ widely, a fact which has caused considerable confusion in the minds of the public as to the aims of the schools. The School of Applied Science offers courses in the different branches of engineering, requirements for admission including a certificate of graduation from an approved high school, or its equivalent, and in addition examination in certain fundamental subjects. The School of Applied Design, which is of about the same scholastic pitch, offers at present courses in architecture, interior decoration and illustration; later it is proposed to extend their work to allied fields. The School of Applied Industries offers industrial courses which are designed to meet the demand for men efficient in the machinery and building trades. The Woman's School trains students in the home-making arts and to become wage earners in case of need.

In view of the brief period of existence of the schools a short statement of some of the features of the work, particularly as relates to the School of Applied Science, may not be out of place. As in the other schools of the organization, both day and night courses are offered, between which the total enrollment of 750 students is about equally divided. The schedule of the first year in the day courses, and of the first two years in the night courses, is the same for all students. This period is devoted to training in subjects that are considered fundamental to the practice of engineering, such as English, mathematics, drawing, chemistry, physics and shop practice. At the end of this period the student, in consultation with the faculty, selects the particular branch of engineering which he intends to follow, being assisted in his selection by a series of lectures by the heads of the departments.

The following day courses are offered: Chemical, civil, commercial, electrical, mechanical, metallurgical, mining and sani-

tary engineering. The course in commercial engineering will be given for the first time in the year 1911–12 and it is designed to afford the student such a combination of technical and commercial training as will prepare him especially for the commercial side of engineering work. No special courses are permitted in the day school.

The industrial life of Pittsburg offers a peculiarly attractive field for technical instruction in a night school. The night enrollment may be divided into two main classes: First, the high school graduate who has become engaged in some line of technical work but has little or no technical training; second, the student who has had some training in a college or technical school who feels the need of special instruction in the line of work which he is following. The first class are largely enrolled in the regular courses of study, while the latter are admitted to special courses. The regular courses require attendance for five years for four nights a week, or for seven years for from three to four nights a week. These courses, while they do not contain some of the subjects of the day school, such as modern language, economics, etc., offer instruction in the main subjects of an engineering course, being designed to fit in with the practical work of the student in his daily employment.

This short sketch will, it is hoped, give some idea of the brief history and development of the schools with which the Society is to meet this year.

THE UNIVERSITY OF PITTSBURGH.

BY DEANS F. L. BISHOP AND M. E. WADSWORTH.

The University of Pittsburgh was established as the Pittsburgh Academy, February 28, 1787. It will, therefore, be 125 years old on the twenty-eighth of February, 1912. It is the oldest educational institution west of the Allegheny Mountains, with one possible exception. It now offers instruction in the following schools: College, School of Engineering, School of Mines, School of Education, School of Economics, Graduate School, School of Astronomy (Allegheny Observatory), School of Medicine, School of Law, School of Dentistry, School of Pharmacy.

During the present year, there have been in attendance 1,621 students, which is almost exactly double the number in attendance five years ago. There are over 200 professors and instructors in its eleven schools.

The campus contains a little over forty-three acres and is located in the Bellefield District near the Carnegie Institute, Schenley Park, Soldiers' Memorial, Technical Schools, Pittsburgh Athletic Club, Eighteenth Regiment Armory, Forbes Field, and many other similar institutions. The buildings on the campus at present include State Hall (School of Mines), Thaw Hall (School of Engineering) and Pennsylvania Hall (School of Medicine). There is in the process of erection, a gymnasium and stadium, the gift of Mr. J. C. Tress, a graduate of the School of Engineering.

The Allegheny Observatory, which is the School of Astronomy of the University, is located in Riverview Park, North Side, and was erected at a cost of about $300,000 donated by the citizens of Pittsburgh. It contains, among other instruments, the 13-inch refractor by Alvan Clark, which was used by Professors Langely and Keller in their famous researches. The 30-inch refractor, which is now being placed, is the third largest in this country and is the only one to be corrected for photographic rays. The entire cost of this tele-

scope will exceed $100,000. The observatory furnishes time for the Pennsylvania Railroad, the city of Pittsburgh, etc.

The Schools of Law, Dentistry and Pharmacy are located in the down town district of the city. The School of Law being across the street from the Court House, the students are enabled to make use of the Law Library of Allegheny County.

The College, the Schools of Engineering, Mines, Education and Economics together with the Graduate School, are located on the campus.

The Schools of Education and Economics were organized during the past year to meet the particular needs of this community. The School of Education coöperates with the different educational institutions in this vicinity; the students being required to do a certain amount of practical teaching and inspection during their junior and senior years.

The engineering work of the university is under the direction of the School of Engineering, which offers courses in civil, mechanical, electrical, chemical and sanitary engineering; and the School of Mines which gives courses in mining, metallurgical, geological and ceramic engineering. The work of the School of Engineering is conducted under the coöperative system which provides for the usual theoretical courses and in addition twelve months of practical work, all in the space of four years. The school work is so arranged that successive groups of students furnish continuous service to the employer.

The equipment of the School of Engineering is new and represents in every way the most modern development of apparatus for student use. Among the more important machines may be mentioned the three universal testing machines ranging from 50,000 to 200,000 lbs. capacity for tension, compression and flexure tests. The 200,000 lb. capacity machine will take 15-foot columns and flexure specimens up to 20 feet. There is also a 230,000-inch pound torsion machine with a 3-inch chucking capacity and capable of taking lengths up to 15 feet.

There is also a Babcock & Wilcox 100-h.p. 200-pound pressure boiler, with a superheating chamber, arranged for making tests on natural gas and provided with all the necessary

appliances for making these tests. This is connected to a 100-h.p. composite cross compound steam engine having cylinders 7½ and 18 by 14 inches arranged to run either as a condensing or non-condensing engine and provided with friction brake and all other appliances for a detailed study of steam engines. Three Westinghouse gas engines—one two-cylinder and two three-cylinder—are arranged for tests with natural gas as a fuel.

The dynamo laboratory is especially designed for student work, being equipped with machines large enough to give suitable quantities to be measured, and at the same time easy to move from one place to another. They are mounted upon especially designed cast-iron testing tables which are provided for this work. These include the usual assortment of direct current generators, motors, single phase and polyphase induction motors, single phase series motors, two phase and three phase synchronous converters, a.c.–d.c. motor generator set, etc.

The department of Chemical Engineering and Industrial Chemistry are very closely affiliated. The latter is a graduate department and provides for a total of about fifty industrial fellowships. These fellowships are for research work in industrial chemistry along lines beneficial to the business of the donors. They cover amounts ranging from $750 to $3,000 per annum.

The School of Mines was organized in 1895, and reorganized in 1908, covering the fields of Ceramics, Geography, Geology, Metallurgy, Mineralogy, Mining, Mining Economics, Mining (Economic) Geology, Mining Law, Mining Surveying, Ore Dressing, Coal Washing, Paleobotany, Paleontology, and Petrography. The instruction covers pure and applied science, and provision was made in 1908 for a student to obtain a year's credit in practical (co-operative) work and for him to have the best education available for Mining, Geological, and Metallurgical Engineers, and Operators or Managers. A new Mining building has been erected, equipment obtained, and both attendance and faculty increased 900 per cent. in 2½ years.

Advance copy of report to be presented at the nineteenth annual meeting of the Society for the Promotion of Engineering Education, at Pittsburgh, Pa., June 27, 28, 29, 1911. Communications regarding this report should be addressed to the Chairman Prof. J. J. Flather, University of Minnesota, Minneapolis, Minnesota. Written discussion is solicited.

REPORT ON ENTRANCE REQUIREMENTS AND DEFINITION OF SUBJECTS PRESENTED BY COMMITTEE ON ENTRANCE REQUIREMENTS.

To the Society for the Promotion of Engineering Education:

Your Committee on Entrance Requirements herewith presents the following report:

Definition of Unit.

A unit course or credit required for entrance is understood as representing work equivalent to that covered in a school year of thirty-six weeks, five periods per week, each period not less than forty minutes in the clear: this includes an aggregate of one hundred and twenty 60-minute hours of class room work. It is further understood that two periods of laboratory, or manual training (including drawing) is equivalent to one period of class room work.

Following the standard established by the Carnegie Foundation for the Advancement of Teaching, fourteen units will constitute the minimum amount of preparation which may be accepted for entrance.

If in the aggregate four studies be pursued each year for a period of four years it will be possible to qualify in sixteen units; a unit therefore constitutes practically one fourth of a year's work.

The selection of subjects which will be accepted for entrance is to a certain extent left to the individual colleges, but there is a marked tendency toward uniformity of requirement with certain studies and a fair degree of freedom regarding the remainder of the subjects. This your committee believes to be right but desires to emphasize the danger in too great freedom in the choice of electives.

In a previous report of the committee (see Vol. IV.) it was stated that: "The committee regards absolute uniformity of requirements as entirely inconsistent with the diversity of educational conditions in different states, and as not in itself desirable.

"Needless arbitrary deviations from uniformity in mere details are vexatious and harmful to all concerned and should be removed as soon as possible by coöperation between colleges and schools.

"To secure such degree of uniformity as is practicable, the committee recommends the approval by this Society of a definite list of entrance requirements somewhat as follows:

Mathematics.	*Science.*
Arithmetic (complete).	Physical geography.
Algebra, elementary.	Botany.
Algebra, through quadratics.	Chemistry.
Algebra advanced.	Physics.
Geometry, plane.	
Geometry, solid.	
Trigonometry, plane.	
Language.	*General.*
English.	Free hand drawing.
French.	United states history.
German.	Some second subject in history.
Latin.	

It may be remembered that the list of studies actually required for admission to technical colleges at the time the former report was written included a large number of subjects, among which we note:

"Writing, reading, partial arithmetic, mensuration, elementary mechanics, higher mathematics, civil government, local government, bookkeeping, elocution, mental science, logic, economics, theory of teaching, Milne's "Realm of Nature," zoölogy, astronomy, geology, mineralogy, meteorology, natural history, biology, introduction to science, ety-

mology, Latin elements of English, Spanish and Greek. This diversity crept in to some extent, no doubt, through the attempt on the part of the colleges to meet the varying courses of their contributory schools through a system of options in requirements, and possibly, to make the scientific courses level up to the classical ones without the necessity of imposing the dead languages on the student. But the effect was to scatter and produce confusion on the one hand, and to limit each college to its own field of cultivated schools on the other."

The report states further:

"There is enough within the above list, that so many colleges agree upon, to fully occupy the time of any boy in his four years in the high school, and there is variety enough to give breadth of training. There is work in the five chief lines of mathematics, language and literature, history, science and art. Any school course, on the one hand, and any college set of requirements, on the other, ought to include all of these lines.

"Again, while the colleges should confine themselves to the above subjects, there is nothing in the list that does not properly fit into the school curriculum. Laboratory work of the right kind in physics, chemistry and botany may be found in comparatively few schools, but it ought to be given in all high schools with four-year courses, for their own sakes, irrespective of the demands of scientific colleges.

"Somewhat apart from the other subjects named, stands manual training, including shop work and mechanical drawing.

"It is obviously impossible—even if desirable—to make either of these a requirement for admission to engineering colleges generally. On the other hand, the engineering colleges should be the first to recognize the true value of hand and eye work as a form of education. The committee believes that, so far as practicable, such recognition should be more generally shown by the acceptance of certified work in manual training as an optional requirement by institutions accepting any optional subjects."

It is very gratifying to note the change that has taken place since the report quoted was presented. With few exceptions the list of subjects proposed at that time includes the essential requirements now accepted for admission to most of the technical colleges of the country. There has been a marked cooperation between the colleges and secondary schools which has tended toward the establishment of certain standards, both in the kind and character of subjects taught. Of the fourteen or fifteen units required for admission the colleges have demanded preparation in definite prescribed subjects amounting to about one half the total work, while the remainder may be selected from a list sufficiently comprehensive to allow the secondary schools considerable freedom in establishing their courses. Nor does this detract from the intellectual development of those in the secondary schools who do not enter college, since there is general agreement as to the value of the prescribed courses in any scheme of secondary education.

Referring to the list quoted above it will be noted that arithmetic is not, in general, now accepted as an entrance subject; on the other hand, on account of the commercial interests of the United States there has grown up a demand for the study of Spanish in the public schools and this subject should be added to the language group.

Zoölogy is frequently studied in the secondary schools instead of botany, and this subject should be included in the science group.

In many well-organized secondary schools the study of history is pursued for the entire four years and the general group should be modified by adding the four history subjects most commonly taught, or preferably, a new history group should be introduced: This should include ancient history; medieval and modern European history; English history; American history or American history and civil government.

The general introduction of manual training (shop work and drawing) into the secondary schools has caused a number of colleges, both academic and technical, to accept a certain

amount of this work in lieu of other subjects for entrance. Shop work and mechanical drawing should therefore be offered in the list of electives acceptable to the engineering college.

Your committee recognizes that there will necessarily be differences of opinion as to the amount of credit which can be accepted for entrance by the college for manual training subjects, but substantial agreement will probably exist if the credit be restricted to one unit for shop work and one unit for drawing.

However, with the credits thus restricted it must be pointed out that in order to qualify in fourteen units as specified, a student taking work in manual training must either limit the amount of this work, or he must take other studies additional to the manual training subjects.

A restriction should also be placed on the language group: That is, if a language be offered for entrance two units should be presented for any one language. This will tend to prevent that "browsing around" which is both harmful and pernicious.

The modified list of subjects among which are to be found the entrance requirements for engineering colleges would be as follows:

Mathematics.	*Science.*
Algebra, elementary.	Physics.
Algebra, higher.	Chemistry.
Geometry, plane.	Botany.
Geometry, solid.	Zoology.
Trigonometry, plane.	Physical geography.

Language.	*History.*
English.	Ancient.
French.	Modern European.
German.	English.
Spanish.	American.
Latin.	

General.

Manual training. Shop work.
Mechanical drawing.
Free-hand drawing.

The prescribed subjects taken from the above list should include:

Algebra, elementary ..... One unit.
Algebra, higher ..... One-half unit.
Geometry, plane ..... One unit.
Geometry, solid ..... One-half unit.
English ..... Three units.
One other language ..... Two units.
or physics or chemistry ..... One unit.
Total prescribed subjects eight units or seven units.

DEFINITION OF REQUIREMENTS.

MATHEMATICS.

The definitions of requirements in mathematics are, with slight modifications, essentially the same as those formulated by the Committee on Mathematics of the North Central Association of Colleges and Secondary Schools presented at the Chicago meeting, March, 1910.

A. Three chief aims should be set for instruction in mathematics: (1) To inspire and facilitate the acquisition of knowledge in an important field. (2) To develop the ability to apply this knowledge to practical and theoretical investigations. (3) To develop and strengthen the ability to perceive exact relations and to make inferences correctly; the teacher's constant aim should be to train the pupil to think and to formulate clearly the results of his thinking.

B. Students completing a high school course and presenting themselves for admission to college should show: (1) A fair degree of accuracy and rapidity in calculation. (2) A fair degree of skill in making algebraic transformations. (3) The

ability to use the equation as an instrument in the solution of problems. (4) The ability to interpret algebraic results. (5) A fair comprehension of what constitutes a proof in mathematics. (6) A good knowledge of the facts of elementary algebra, and plane and solid geometry.

C. Students during the last high school year, because of their greater maturity, have much more ability to grasp the abstract thinking of mathematics than do students of the earlier years. The material offered in the courses and the methods of instruction should be determined with this in view. At first the simpler and more concrete ideas of the subject should be dealt with. In later stages, more complicated mechanical work and formal theory should be introduced gradually.

It is strongly urged by your committee that the study of mathematics in preparatory schools be encouraged throughout the last school year.

It is becoming more and more evident that a change in the arrangement of the subject matter involved is desirable.

Under any arrangement, arithmetic, algebra, geometry and trigonometry should be regarded and treated as different phases of one and the same subject. The geometrical, the arithmetical, algebraic and physical phases of mathematics should be presented as far as possible from the beginning to the end of the secondary course. Much can be done in this direction by employing geometrical methods in algebra and by using algebraic processes in geometry. Numerous examples taken from physics, and problems illustrated graphically taken from any source whatever may be advantageously employed.

ALGEBRA 1A AND 1B.

FORMULATION I.—One and a half units.

The algebra required for entrance to college should include the following topics (no significance to be attached to the order given here): (1) The fundamental laws of algebra. (2) The general view of algebraic number. (3) The four fundamental

operations as applied to integral, fractional and irrational expressions. (4) Factoring. (5) Binomial theorem for positive integral exponents. (6) Solution of equations in one variable including simple quadratic, fractional and irrational equations. (7) Solution of systems of equation in two variables; including linear system, linear-quadratic system and a few of the quadratic systems that occur more frequently in practise. (8) Ratio and proportion. (9) The statement and solution of problems.

It is recommended that this unit and a half be divided into two portions, an elementary course, Algebra 1a, to be given in the first year of high school and a more advanced course to be given after the course in plane geometry in the third or fourth year.

The following suggestions are made as to the character of these courses.

Algebra 1a should deal with the simpler portions of the topics named, with the exception of the greater portion of 7, which should be treated in Algebra 1b.

Omit complicated forms of parentheses, fractions, irrationals, types of factoring and equations. The aim should be a training in algebra as a method of thinking rather than as an exercise in the manipulation of complicated expressions. Ideas and methods should grow out of the pupils' knowledge of arithmetic and the relations of common experience. The traditional order of topics is not to be commended. Emphasis should be placed on the equation as a means of solving problems, other topics contributing assistance as the need arises. The equation should be used at the very beginning, as it is of paramount importance throughout the course.

The second course, Algebra 1b, should be a more systematical and scholarly consideration of the ground already covered and an extension of ideas to more complicated expressions. By the time the student has finished this course he should have acquired that facility in the use of algebraic expressions which is so essential to the further study of mathematics. A mastery of the fundamentals of theory and practise must be insisted upon.

PLANE GEOMETRY, 2.

FORMULATION II.—One unit.

The usual theories and constructions of good text-books, including the general properties of plane rectilinear figures; the circle and the measurement of angles; similar polygons; areas; regular polygons and the measurement of the circle.

The solution of numerous original exercises, including loci problems.

Applications to the mensuration of lines and plane surfaces.

In plane geometry it is suggested that a clearer conception of geometrical reasoning and a firmer grasp upon geometrical facts can be acquired by a thorough consideration of a small number of theorems than by a hurried glance at a larger number. It is therefore recommended that the more important theorems be emphasized and that the less important theorems be omitted or passed over without proof. It is suggested that teachers be free to assume the truth of some of the most evident theorems at first. Proof may be given later if desired. The original demonstration of theorems is of the utmost importance. The use of exercises involving algebraic and numerical applications is to be encouraged. The habit of giving accurate definitions, the perception of what constitutes a demonstration of truth, confidence in one's own power of correct reasoning and the ability to discover geometrical relations are of more importance than the ability to recall the demonstration of a large number of theorems. It would be well to omit the theory of limits and incommensurables from this course.

SOLID GEOMETRY, 3.

FORMULATION III.—One half unit.

Solid geometry should comprise the usual topics given in texts, including the relations of planes and lines in space; the properties and measurement of prisms, pyramids, cylinders and cones; the sphere and the spherical triangle.

The solution of numerous original exercises, including loci problems.

Here too, there should be a centering of attention upon the more important theorems. More emphasis should be placed on mensuration.

It may be desirable in some schools to re-arrange the material of courses 2 and 3 so that course 2 should include the elements of both plane and solid geometry, leaving to course 3 the more difficult phases of the subject.

PLANE TRIGONOMETRY.

FORMULATION IV.—One half unit.

If plane trigonometry be offered it should include the definitions and relations of the six trigonometrical functions as ratios, the theory of logarithms, and use of tables, the proof of important formulae, the solution of right and oblique triangles, and considerable practise in trigonometric transformations.

PHYSICS.

The requirement in physics based on the report of the Committee on Physics of the Science Department of the National Educational Association appears to be too comprehensive for the average high school, in fact, it has been stated that only three or four high schools of the country are in a position to teach the physics as outlined in the above report and your committee believes that the number of required topics should be reduced so as to more nearly meet the existing conditions as found in the average high school throughout the country.

FORMULATION V.—One unit.

It is recommended that the candidate's preparation in physics should include:

1. The study of at least one standard text-book, supplemented by the use of numerical problems, "to the end that the pupil may gain a concise and connected view of the most important facts and laws in elementary physics."

2. Individual laboratory work comprising at least twenty-five exercises selected from a list of fifty or more, not very different from the list given below.

3. Instruction by lecture-table demonstrations to be used mainly as a basis for questioning upon the general principles involved in the pupil's laboratory investigations.

The time devoted to this subject should be not less than one year of five periods per week. At least one fourth of the time must be devoted to laboratory work, which should consist of double periods of not less than 80 minutes each. Thoroughness and intelligent methods are desired rather than a fund of information.

The following list of suggested topics has been prepared by the Committee on Definition of Physics of the North Central Association of Colleges and Secondary Schools. It includes all those topics which are essential to an elementary course in physics, but it is not intended to restrict the teacher to the list here presented, since individual environment may demand modification.

1. Weight, center of gravity.
2. Density.
3. Parallelogram of forces.
4. Atmospheric pressure; barometer.
5. Boyle's law.
6. Pressure due to gravity in liquids with a free surface; varying depth, density, and shape of vessel.
7. Buoyancy; Archimedes' principle.
8. Pascal's law; hydraulic press.
9. Work as force times distance, and its measurement in foot-pounds and gram-centimeters.
10. Energy measured by work.
11. Law of machines: work obtained not greater than work put in; efficiency.
12. Inclined plane.
13. Pulleys, wheel and axle.
14. Measurement of moments by the product of force times arm; levers.
15. Thermometers: Fahrenheit and Centigrade scales.
16. Heat quantity and its measurement in gram calories.
17. Specific heat.

18. Evaporation; heat of vaporization of water.
19. Dew point; clouds and rain.
20. Fusion and solidification; heat of fusion.
21. Heat transference by conduction and convection.
22. Heat transference by radiation.
23. Qualitative description of the transfer of energy by waves.
24. Wave-length and period of waves.
25. Sound originates at a vibrating body and is transmitted by waves in air.
26. Pitch and period of sound.
27. Relation between the wave length of a tone and the length of a string or organ pipe.
28. Resonance.
29. Beats.
30. Rectilinear propagation of light; pin-hole camera.
31. Reflection and its laws; image in a plane mirror.
32. Refraction, and its use in lenses; the eye, the camera.
33. Prisms and dispersion.
34. Velocity of light.
35. Magnetic attractions and repulsions.
36. Field of force about a magnet.
37. The earth a magnet; compass.
38. Electricity by friction.
39. Conductors and insulators.
40. Simple galvanic cell.
41. Electrolysis; definition of the ampere.
42. Heating effects; resistance; definition of the ohm.
43. Ohm's law; definition of the volt.
44. Magnetic field about a current; electromagnets.
45. Electromagnetic induction.
46. Simple alternating current dynamo of one loop.
47. Electromagnetic induction by breaking a circuit; primary and secondary.
48. Conservation of energy.

At the time of the examination the candidate must present a note-book in which he has recorded the steps and the re-

sults of his laboratory exercises, and this note-book must bear the endorsement of his teacher, certifying that the notes are a true record of the pupil's work. It should contain an index of the exercises which it describes. It is practicable for pupils to make the original record of their observations entirely presentable, so that copying will be unnecessary, and they should in general be required to do so.

CHEMISTRY.

The requirement in chemistry is based on the report of the Committee on Chemistry of the Science Department of the National Educational Association and is subject to the same criticism which has been made regarding the definition for physics. The criticisms on this requirement given by the various professors of chemistry in the technical colleges indicate that the high schools are attempting to teach college courses without proper equipment and facilities and that it would be better to have a less comprehensive course which could be well taught in the average high school than to attempt to cover so much ground which at best can be accomplished only superficially in the average high school. With this in view, the following formulation is offered as a definition of the requirement in chemistry.

FORMULATION VI.—One unit.

The following outline includes only the indispensable things which must be studied in the class-room and laboratory. The material is, for the most part, common to all elementary text-books and laboratory manuals. Each book makes its own selection of facts beyond that which may be necessary for the illustration of the principles of the science. The order of presentation will naturally be determined by each teacher for himself.

Outline.—The chief physical and chemical characteristics, the preparation and the recognition of the following elements and their chief compounds: oxygen, hydrogen, carbon, nitrogen, chlorine, bromine, iodine, fluorine, sulphur, phosphorus,

silicon, potassium, sodium, calcium, magnesium, zinc, copper, mercury, silver, aluminum, lead, tin, iron, manganese, chromium.

More detailed study should be confined to a restricted list of compounds, such as water, hydrochloric acid, chlorine, sodium hydroxide, and sodium carbonate.

Attention should be given to the atmosphere (constitution and relation to animal and vegetable life), flames, acids, bases, salts, oxidation and reduction, crystallization, manufacturing processes, familiar substances (illuminating gas, explosives, baking powder, mortar, glass, metallurgy, steel, common alloys, porcelain, soap).

Combining proportions by weight and volume; calculations founded on these and Boyle's and Charles' law; symbols and nomenclature (with careful avoidance of special stress, since these are non-essential); atomic theory, atomic weights and valency in a very elementary way; nascent state; natural grouping of the elements; solution (solvents and solubility of gases, liquids and solids, saturation); strength (=activity) of acids and bases; conservation and dissipation of energy; chemical energy (very elementary); electrolysis. Chemical terms should be defined and explained, and the pupil should be able to illustrate and apply the ideas they embody. The theoretical topics are not intended to form separate subjects of study, but to be taught only so far as is necessary for the correlation and explanation of the experimental facts.

It is recommended that the candidate's preparation in chemistry should include:

1. The study of at least one standard text-book to the end that the pupil may gain a comprehensive and connected view of the most important facts and laws of elementary chemistry.

2. Individual laboratory work comprising at least twenty-five exercises selected from a list of fifty or more, not very different from the list given below.

3. Instruction by lecture-table demonstrations to be used mainly as a basis for questioning upon the general principles involved in the pupil's laboratory investigations.

The time devoted to this subject should be not less than one year of five periods per week, of which at least one third should be spent in laboratory work. All laboratory periods should be double and consist of not less than eighty minutes each.

List of Experiments.

General.

1. Composition of the atmosphere.
2. Dissociation of mercuric oxide, and study of resulting products.
3. Burning of magnesium and sodium in air, and of iron in oxygen, with study of resulting products.
4. Burning of sulphur and phosphorus in air; study of products.
5. Treatment of substances resulting from (3) with hydrochloric acid, and examination of final products.

Laws of Gas Volumes and Vapor Tension.

6. Boyle's Law.
7. Charles' Law.
8. Vapor tension.

Common Elements and Compounds.

9. Preparation and study of oxygen.
10. Liberation of hydrogen by action of sodium on water. Careful study of by-product.
11. Preparation of hydrogen by zinc and acid. More thorough study of hydrogen in larger quantities; study of by-product.
12. Proportion of volume in which hydrogen and oxygen unite. (Lecture demonstration with eudiometer.)
13. Proportion by weight in which hydrogen and oxygen combine. (Lecture experiment.)
14. Change of boiling point and freezing point as affected by concentration.
15. Taste of substance produced by combining oxygen and hydrogen; action on litmus.

16. Electrolysis of water, resulting gases being accurately measured and tested.
17. Study of sodium, potassium, strontium, calcium and barium compounds.
18. Study of soda processes.
19. Study of salts of cobalt, copper, nickel, manganese, chromium, iron.
20. Study of compounds of aluminum, magnesium and zinc.
21. Preparation and study of chlorine gas.
22. Combustion of chlorine in hydrogen.
23. Preparation of hydrochloric acid and study of properties.
24. Preparation and study of at least three chlorides.
25. Preparation and study of bromine.
26. Preparation of at least three bromides.
27. Preparation and study of iodine.
28. Preparation of at least three iodides.
29. Study of hydrofluoric acid and fluorides.
30. Study of forms of sulphur.
31. Direct formation of sulphides.
32. Study of sulphurous oxide.
33. Preparation of sulphurous and sulphuric acids.
34. Preparation of at least two sulphites and two corresponding sulphates. Comparative study of these.
35. Decomposition of ammonium nitrate and study of nitrous oxide.
36. Preparation and study of nitric acid.
37. Preparation of three nitrates in three different ways.
38. Composition of gas formed by action of cold dilute nitric acid on copper.
39. Composition of gas formed by union of nitric oxide and oxygen.
40. Preparation of ferrous and ferric salts.
41. Stability of salts on heating dry.

Carbon and some Carbon Compounds.

42. Product of burning charcoal. Tests.
43. Test for presence of carbon in wood, paper, kerosene, coal gas, alcohol.

44. Preparation of three carbonates.
45. Solubility of carbonates in the presence of carbon dioxide.
46. Effect of heat on suspension of carbonates in solution.
47. Carbon dioxide from fermentation.

A knowledge of the more important chemical industries, and ability to work simple problems will be required.

At the time of the examination the candidate must present a note-book in which he has recorded the steps and the results of his laboratory exercises, and this note-book must bear the endorsement of his teacher, certifying that the notes are a true record of the pupil's work. It should contain an index of the exercises which it describes. It is practicable for pupils to make the original record of their observations entirely presentable, so that copying will be unnecessary, and they should in general be required to do so.

The following notes taken from the report of the Committee on Definition of Requirement in Chemistry, North Central Association of Colleges and Secondary Schools, are worthy of careful attention.

"Disregarding questions of order, and simply classifying the essential principles of instruction, the pupil should be taught:

"1. Technique of experimentation.

"Properties of common apparatus in respect to structure and material. For example, how to make an apparatus air-tight and why. Object of such operations as washing and drying gases and how the object is attained.

"Physical properties which may be used for recognition of each substance and for explanation of all observations.

"Judicious use of properties and materials. Influence of conditions (temperature, homogeneous and heterogeneous mixture, etc.) on chemical change.

"2. Physical phenomena, their recognition, description and physical interpretation.

"3. The more strictly chemical application of the results. For example, inference in regard to the nature of the chemical change which must have led to the results observed. Making of the chemical equation from adequate data."

ENGLISH.

The requirement in English is that recommended by the Conference on Uniform Entrance Requirements in English for the years 1913, 1914 and 1915.

FORMULATION VII.—Three units.

Preparation in English has two main objects. (1) command of correct and clear English, spoken and written; (2) ability to read with accuracy, intelligence, and appreciation.

The first object requires instruction in grammar and composition. English grammar should ordinarily be reviewed in the secondary school; and correct spelling and grammatical accuracy should be rigorously exacted in connection with all written work during the four years. The principles of English composition governing punctuation, the use of words, paragraphs, and the different kinds of whole composition, including letter writing, should be thoroughly mastered; and practice in composition, oral as well as written, should extend throughout the secondary school period. Written exercises may well comprise narration, description, and easy exposition and argument based upon simple outlines. It is advisable that subjects for this work be taken from the student's personal experience, general knowledge, and studies other than English, as well as from his reading in literature. Finally, special instruction in language and composition should be accompanied by concerted effort of teachers in all branches to cultivate in the student the habit of using good English in his recitations and various exercises, whether oral or written.

The second object is sought by means of two lists of books, headed respectively *reading* and *study*, from which may be framed a progressive course in literature covering four years. In connection with both lists, the student should be trained in reading aloud and be encouraged to commit to memory some of the more notable passages both in verse and in prose. As an aid to literary appreciation, he is further advised to acquaint himself with the most important facts

in the lives of the authors whose works he reads and with their place in literary history.

a. Reading.—The aim of this course is to foster in the student the habit of intelligent reading and to develop a taste for good literature, by giving him a first-hand knowledge of some of its best specimens. He should read the books carefully, but his attention should not be so fixed upon details that he fails to appreciate the main purpose and charm of what he reads.

With a view to large freedom of choice, the books provided for reading are arranged in the following groups, from which at least ten units* are to be selected, two from each group:

I. The Old Testament, comprising at least the chief narrative episodes in Genesis, Exodus, Joshua, Judges, Samuel, Kings, and Daniel, together with the books of Ruth and Esther; the Odyssey, with the omission, if desired, of Books I., II., III., IV., V., XV., XVI., XVII.; the Iliad, with the omission, if desired, of Books XI., XIII., XIV., XV., XVII., XXI.; Vergil's Æneid. The Odyssey, Iliad, and Æneid should be read in English translations of recognized literary excellence.

For any unit of this group a unit from any other group may be substituted.

II. Shakspere's Merchant of Venice; Midsummer Night's Dream; As You Like It; Twelfth Night; Henry the Fifth; Julius Cæsar.

III. Defoe's Robinson Crusoe, Part I.; Goldsmith's Vicar of Wakefield; either Scott's Ivanhoe or Scott's Quentin Durward; Hawthorne's House of the Seven Gables; either Dicken's David Copperfield, or Dickens' Tale of Two Cities; Thackeray's Henry Esmond; Mrs. Gaskell's Cranford; George Eliot's Silas Marner; Stevenson's Treasure Island.

IV. Bunyan's Pilgrim's Progress, Part I.; The Sir Roger De Coverley Papers in the Spectator; Franklin's Autobiography (condensed); Irving's Sketch Book; Macaulay's Essays on Lord Clive and Warren Hastings; Thackeray's

* Each unit is set off by semicolons.

English Humorists; Selections from Lincoln, including at least the two Inaugurals, the Speeches in Independence Hall and at Gettysburg, the Last Public Address, and Letter to Horace Greeley, along with a brief memoir or estimate; Parkman's Oregon Trail; either Thoreau's Walden or Huxley's Autobiography and selections from Lay Sermons, including the addresses on Improving Natural Knowledge, A Liberal Education, and A Piece of Chalk; Stevenson's Inland Voyage and Travels With a Donkey.

V. Palgrave's Golden Treasury (First Series), Books II. and III., with especial attention to Dryden, Collins, Gray, Cowper, and Burns; Gray's Elegy in a Country Churchyard and Goldsmith's Deserted Village; Coleridge's Ancient Mariner and Lowell's Vision of Sir Launfal; Scott's Lady of the Lake; Byron's Childe Harold, Canto IV., and Prisoner of Chillon; Palgrave's Golden Treasury (First Series), Book IV., with special attention to Wordsworth, Keats, and Shelley; Poe's Raven, Longfellow's Courtship of Miles Standish, and Whittier's Snow-Bound; Macaulay's Lays of Ancient Rome and Arnold's Sohrab and Rustum; Tennyson's Gareth and Lynette, Lancelot and Elaine, and The Passing of Arthur; Browning's Cavalier Tunes, The Lost Leader, How They Brought the Good News from Ghent to Aix, Home Thoughts from Abroad, Home Thoughts from the Sea, Incident of the French Camp, Hervé Riel, Pheidippides, My Last Duchess, Up at a Villa—Down in the City.

b. Study.—This part of the requirement is intended as a natural and logical continuation of the student's earlier reading, with greater stress laid upon form and style, the exact meaning of words and phrases, and the understanding of allusions. For this close reading are provided a play, a group of poems, an oration, and an essay, as follows:

Shakspere's Macbeth; Milton's L'Allegro, Il Penseroso, and Comus; either Burke's Speech on Conciliation with America, or both Washington's Farewell Address, and Webster's First Bunker Hill Oration; either Macaulay's Life of Johnson, or Carlyle's Essay on Burns.

However accurate in subject matter, no paper will be considered satisfactory if seriously defective in punctuation, spelling, or other essentials of good usage.

The examination will be divided into two parts, one of which may be taken as a preliminary, and the other as a final.

The first part of the examination will be upon ten units chosen, in accordance with the plan described earlier, from the lists headed *reading;* and it may include also questions upon grammar and the simpler principles of rhetoric, and a short composition upon some topic drawn from the student's general knowledge or experience. In grammar and rhetoric, the candidate may be asked specific questions upon the practical essentials of these studies, such as the relation of the various parts of a sentence to one another, the construction of individual words in a sentence of reasonable difficulty, and those good usages of modern English which one should know in distinction from current errors. On the books prescribed for reading, the form of the examination will usually be the writing of short paragraphs on several topics which the candidate may choose out of a considerable number. These topics will involve such knowledge and appreciation of plot, character development and other qualities of style and treatment as may be fairly expected of boys and girls.

The second part of the examination will include composition and those books comprised in the list headed *study.* The test in composition will consist of one or more essays, developing a theme through several paragraphs; the subjects will be drawn from the books prescribed for *study,* from the candidate's other studies, and from his personal knowledge and experiences quite apart from reading. For this purpose the examiner will provide several subjects, perhaps five or six, from which the candidate may make his own selections. The test on the books prescribed for study will consist of questions upon their content, form, and structure, and upon the meaning of such words, phrases, and allusions as may be necessary to an understanding of the works and an appreciation of their salient qualities of style. General questions may also be

asked concerning the lives of the authors, their other works, and the periods of literary history to which they belong.

It is strongly urged by your committee that the study of English in preparatory schools be encouraged throughout the last school year.

(Report to be concluded next month.)

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